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ABSTRACT

While many tools exist for the development of individual Hypertext Markup Language (HTML) pages, few exist for the development of complete hypermedia courses. The HTML Course Creator (HCC), developed by students at the U.S. Military Academy (West Point, New York), allows instructors who are not HTML experts to rapidly develop and easily maintain consistent, distributed hypermedia courses and associated digital libraries. Using a simple point-and-click environment, instructors can add a variety of media types without knowing HTML tags. The tool acts on user input to create a hierarchical course structure and all of the related HTML documents. The course can be tailored to specific styles based on templates that are consistently applied to all course documents. The software also maintains a complete course-wide digital library of all media used within the course by location, media type, media anchor, and lesson. A table presents the components of the initial hypermedia course developed, and figures illustrate the following HCC interfaces--key information, main course, course, lesson, add graphic, and digital library. Contains 12 references. (Author/DLS)

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Automating Hypermedia Course Creation and Maintenance

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Automating Hypermedia Course Creation and Maintenance

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Abstract: While many tools are exist for the development of individual Hypertext Markup Language (HTML) pages, few exist for the development of complete hypermedia courses. The HTML Course Creator (HCC) allows instructors who are not HTML experts to rapidly develop and easily maintain consistent, distributed hypermedia courses and associated digital libraries. Using a simple point-and-click environment, instructors can add a variety of media types without knowing a single HTML tag. The tool acts on user input to create a hierarchical course structure and all of the related HTML documents. The course can be tailored to specific styles based on templates that are consistently applied to all course documents. Furthermore, the software maintains a complete course-wide digital library of all media used within the course by location, media type, media anchor, and lesson. Using the HCC, instructors from a variety of academic backgrounds can create and maintain networked, hypermedia courses accessible over the World Wide Web.

Introduction

Like many other institutions, the United States Military Academy (USMA) has developed hypermedia-based courses using Hypertext Markup Language (HTML) to exploit the World Wide Web (WWW) as a means of enhancing learning outside the classroom. At USMA, development of these course materials has until recently been primarily in the domain of computer scientist and information technologist despite an extensive network infrastructure reaching each student's personal computer. The initial hypermedia course developed at USMA, CS383 Computer Systems, has grown to over 1.2 GB of course material as depicted in [Table 1].

• Lesson Objectives, Note-taking Guides, and Electronic Slideshows for every Lesson	• 143 Audio, 63 Graphic and 57 Digital Movie Files
• 300 pages of course hypertext with 678 terms with pop-up definitions and 600 terms that can be searched on.	• An animated virtual for benchmarking typical computer configurations.
• An adaptive testing system based on Common Gateway Interface (CGI) forms with over 250 questions, hints, and color-coded reporting based on lesson objective and depth of learning according to Bloom's Taxonomy.	• An adaptive hypermedia CGI interface based on Felder's Learning Style Model that tailors the presentation of course material to the learning style of the user.
• A course legacy system with over 275 student papers and slideshows from previous semesters supporting a paperless student submission and grading system.	• An ISMAP-based user interface of over 1500 links interconnecting all course material.

Table 1: Hypermedia CS383 Components

Despite very positive results using hypermedia courseware [Carver & Howard 1995a] and similar efforts at other institutions, many departments at USMA did not immediately move to exploit the WWW for educational hypermedia. The most significant barrier to persuading instructors to invest the enormous amounts of time required to produce and maintain hypermedia materials for courses is the well-justified concern that there may not be a suitable return on this investment. Concerns also exist regarding student

acceptance and learning outcomes, and technological risk-factors associated with hypermedia courseware such as architectural standard isolation, network access bottlenecks, and tool longevity. A mechanism was needed to reduce the amount of time required for hypermedia course development and maintenance. If time requirements were significantly reduced and the methodology was simple yet powerful, then there might be more interest in developing hypermedia courseware.

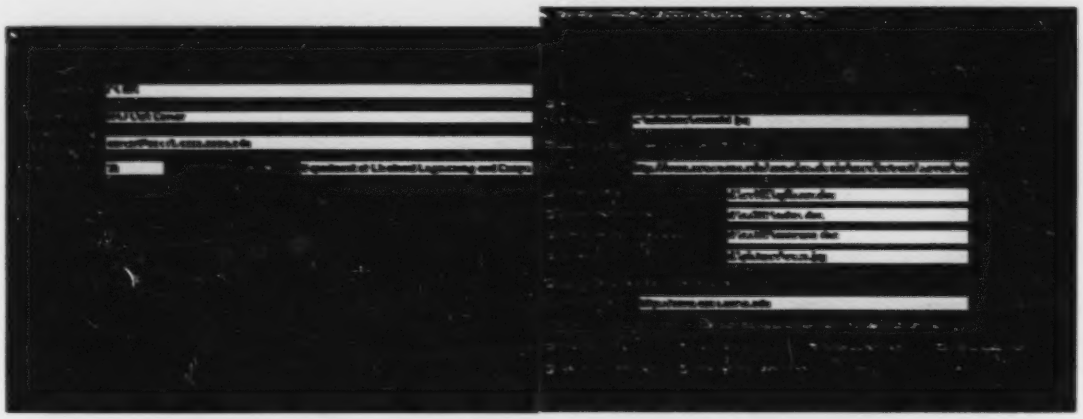

Figure 1: HTML Course Creator Key Information and Main Course Interface

There has also been widespread interest in interconnecting the courseware developed across departmental boundaries so that *hyperdisciplinary* courseware - hypermedia course material from different disciplines - integrated seamlessly through a common interface with rich cross-linking and sharing of resources. Instead of students learning cross products from the mathematics curriculum and then again in engineering courses using separate materials, there could be explicit links between all courses using cross products so that teachers and students could reuse and extend on the course material from different departments. One of the first steps in developing hyperdisciplinary courseware is a tool that standardizes, to a useful degree, the hypermedia course interface. Since the maintenance of substantial quantities of hyperdisciplinary material would be extremely difficult without automated support, what was really needed was a one or more complementary tools with consistent user interfaces that combined hypermedia course development and course maintenance into a single consolidated package. Unfortunately, no such package was known to exist.

Previous Work

A variety of hypermedia tools have been developed such as GETMAS [Wong et al. 1996a], HM-Card [Mayrhofer et al. 1996a], Hypercourseware [Siviter and Brown 1992a], Hypertactics [Mulhauser 1992a], ISAAC [McAleese and Ching 1993a], MALL [Tanaka et al. 1996a], Metaplant [Hedberg et al. 1996a], NEAT [Mayer et al. 1993a, Muldner et al. 1996a], and Nestor [Jonassen and Harris 1991a]. A variety of public domain, shareware, and commercial software tools have been distributed for the development of HTML documents such as *HTML Writer*, *HTML Assistant*, *HotDog Pro*, and *Internet Assistant*. None of these tools provide support for course digital libraries, point-and-click environment for adding MS PowerPoint and MS Word for Windows documents with no required knowledge of HTML, or producing courseware with consistent student interface which are essential for hyperdisciplinary applications. In this regard, this paper describes a tool that is both novel and significantly different from previous efforts in this field.

The Solution - the HTML Course Creator

A group of our students developed a software tool, the HTML Course Creator (HCC), that addressed these problems. This tool facilitates the development and maintenance of hypermedia courseware. Furthermore, the software maintains a complete course-wide digital library of all media used within the course by location, media type, media anchor, copyright source, copyright release, and lesson. Using this tool, the creation and maintenance of large, richly interlinked, hypermedia courses has been both greatly

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simplified and standardized.

Creating a course using the HCC consists of three steps. In *Setting up the Environment*, the instructor enters general course information [See Fig.1] and sets the directory that the HCC will compile into. *During Adding Media*, the instructor adds different media resources to be used in the lessons [See Fig. 2 and 3]. As media is added to the course, it automatically becomes part of the course digital library [See Fig. 3]. In *Course Compilation*, the HCC takes the information entered and generates appropriate HTML code in the compilation directory

The first step in creating a new course is entering the course information [see Fig. 1] and setting up the compilation directories. The information from the course information and main page data entry screens are combined to form the HTML course structure and the main course page. Instructors simply fill-in-the-blanks or indicate the file that they want included. If an option is left blank, a link to the option is not generated when the course is compiled. Instructors can choose between 1 and 40 lessons to include in the course. The program will use this information during compilation to build the course. The compilation directory is the directory where the HCC will create the HTML version of the course. It is normally a sub-directory on the departmental WWW server.

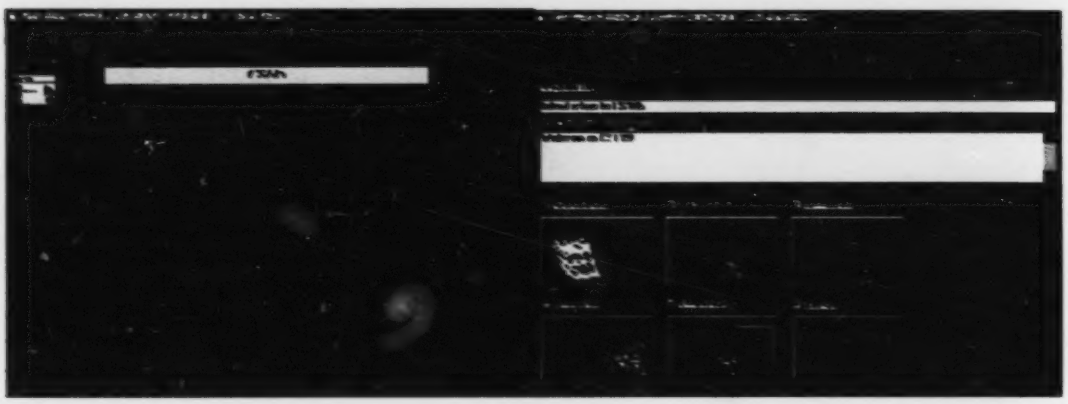

Figure 2: Course Creator Course and Lesson Interface

After selecting a lesson, the HCC allows the faculty member to select various media elements stored in institution- or department-wide servers and include them on the course home page, in the course digital libraries, and in particular lessons [see Fig. 3]. Instructors need only "point-and-click" on the media resource and then add a text description of the media resource.

The HCC intentionally supports incremental development of media. Due to the time required to generate hypermedia courses, few instructors have the time to generate a complete course in a single semester. Instead, most hypermedia courses are generated over several semesters and constantly refined. As instructors generate media, they can add the media to the course. Instructors can start with as little as text-based lesson notes for each lesson and then incrementally develop the course until it includes text, slideshows, audio files, graphics files, digital movies, and links to other WWW sites.

During compilation, all of the files indicated by the instructor are copied to the compilation directory according to a predefined directory and file structure. The HCC will then dynamically build links to all of the media files and insert the information entered by the instructor according to predefined HTML templates. These HTML templates support the ladder model of hypermedia courseware where media is linked both by lesson and by media type [Haga & Nishino 1995a]. This provides multiple paths through the course material that the user can select based on their preference. Currently the program supports two templates although additional templates can be added to provide a new HTML structure.

When a course is compiled, the HTML code is generated according to the template selected. The template defines the appearance of the HTML pages. Currently, two templates have been implemented . The first template compiles the HTML code so that course information is connected through simple

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HTML links. The second template provides inline graphics in addition to the first approach. Both approaches provide a simple, yet orthogonal user interface. Once students have learned how to use the interface of one course developed by the HCC, they will have learned the interface into any other course developed by the HCC.

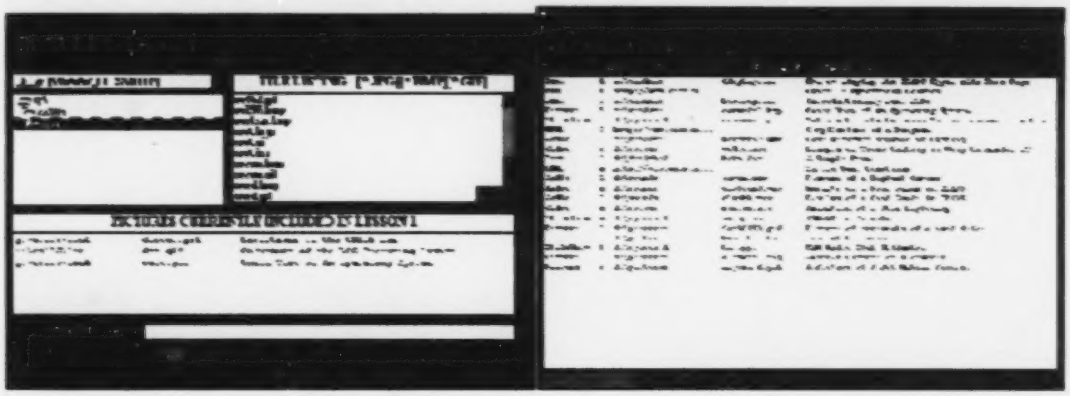

Figure 3: Add Graphic Interface and Digital Library Interface

The maintenance of a course built with the HCC is easy. As an instructor builds the course, the HCC maintains a project file with all of the information previously entered . Professors can easy copy and paste media elements between lessons or view media usage through the HCC digital library. Work is currently ongoing to provide drag-and-drop lesson reordering.

The maintenance of networked hypermedia, not the rapid generation of courseware, is the greater concern for course developers. The HCC simplifies tracking what media is used in what lesson and associates a plain text description of media with the media file. Media can be tracked by all of the different types [see Fig. 3] or it can be tracked by media type. This provides a simple yet effective mechanism for dynamically tracking what media is used in what lesson.

Advantages and Disadvantages of the Course Creator

The HCC provides six major advantages: it is a course-based, not page-based HTML development tool; simple professor interface; incremental course development with the ability to link in shared and personal media elements; consistent student interface and hyperdisciplinary course support; production of a course digital library; and modest machine and network resources required for effective use. Unlike other tools, the HCC supports a course-based approach to the development of hypermedia courseware instead of a file-based approach. This object-based approach more closely models other, more traditional methods of course development, and as such is easier and more natural to use.

The simple point-and-click professor interface complements the course-based approach by supporting instructor development of hypermedia courseware without a need to know HTML. This allows professors to focus on the content of the media added and not on HTML. It is believed that this will greatly reduce the amount of time required to create a course. Incremental course development allows instructors the flexibility to develop as much or as little of the hypermedia course as time or desire permits. Few professors have the time to monolithically develop gigabytes of course material. Incremental development is often the only viable approach for hypermedia courseware. Instructors may begin with a simple course outline and lesson objectives and as time and other resources permit, develop and include other media resources such as lesson notes, slideshows, sound files, graphics, movies, and links to other information sources. Furthermore, the media elements developed can be easily shared with other courses due to the consistent directory structure produced by the HCC.

The HCC provides a consistent student interface. Once a student learns how to use the interface in one course, the student knows how to use the interface in any other course. This allows for seamless

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cross-linking between courses and integration of courses across departmental boundaries and eventually, hyperdisciplinary course support. Without a tool such as the HCC, hyperdisciplinary courseware is essentially impracticable.

The HCC requires moderate machine and network resources. It has been successfully used on relatively modest platforms (slow 80486 machines with 8MB of RAM, 500MB local hard drives, and standard shared 10 Mbps Ethernet network connection). It outputs standard V1.0 HTML, so a wide variety of Web browsers can be used to access the courseware created. Network file server and Web server requirements will, of course, still vary with the amount of material being used and the number of simultaneous student accesses anticipated.

The HCC has three major disadvantages: lack of flexibility in course design, no support for Common Gateway Interface forms, and no support of incremental compilation. The lack of flexibility limits course design to one of the two templates available in the HCC. Instructors cannot individualize their course using other HTML editors as the tool will overwrite these changes the next time the course is compiled. Likewise, there is no support for CGI forms, Java scripts, frames, or some of the other emerging features of HTML. While these are significant disadvantages, hyperdisciplinary courseware will not be possible without some standard interface. Furthermore, because the HCC was designed to dramatically reduce the amount of time required to create an HTML-based course, inclusion of these features would not facilitate rapid course development. A powerful, yet simple tool was needed.

Lack of incremental compilation remains a limitation of the current system. When the HCC recompiles a course, it recopies all of the media elements to the HTML directory and recreates all of the code necessary to link the course together. This overwrites any previous code or changes made to that code from other HTML editors. Clearly, it would be more cost efficient in terms of time and network bandwidth to only changes those portions of the course that had been altered. It is the intent of the authors to add this feature to the software over time.

Longevity of the HTML Course Creator

A problem with any locally developed software artifact lies in finding viable ways to maintain and extend it over a sustained period of time. Even reliance on commercial products does not alleviate all of these concerns. Few instructors will desire to commit to a tool whose problems are unfixable and which can not evolve to match developments in the problem domain it purports to address. Currently, much of the coding and testing work which has and will go into evolving the HCC is undertaken by the annual crop of senior students undertaking software design group projects; strategic direction and oversight remain with knowledgeable faculty members. In this mechanism is a fortuitous linkage between the desire of most groups to create a new artifact reflecting their own creativity and development tool preferences, and the need to substantially modify hypermedia courseware tools every year to keep up with changing standards and instructor requirements. A prior year's working tool becomes the living specification of the existing baseline requirement (adjusted for known bugs) and the basis for prototyping the current year's extensions and modifications. The long term viability of this approach to evolving the HCC remains to be seen, but it has so far proved reasonably effective and admirably (though not optimally) economizing of faculty time.

The HCC is currently being used in several departments at USMA as the basis for hypermedia course creation. Faculty members as well as the department leadership from several departments have been enthusiastic. One department has decided that all hypermedia courseware within the department will be developed using the HCC. Validation of exactly how much time is saved and the degree of acceptance among professors who had previously been unwillingly to exploit the WWW remains an ongoing research topic.

Summary and Future Research

The HCC simplifies the creation of hypermedia courseware. Through a simple point-and-click interface, professors can rapidly and easily build hypermedia courses. Construction of the hypermedia course is focused on lesson construction and not page construction as other tools require. No knowledge of HTML

is required. Maintenance of a HTML-based course is likewise simplified with digital library support and media tracking. Requiring only modest platform support, the HCC supports the development of hyperdisciplinary courseware. It represents a first step in providing hypermedia courseware design software that anyone and everyone could use.

Future research into the HCC is focused on enhancement and assessment. Incremental compilation, support for the "chunking" of related lessons, color-coding material that must be updated on a semester basis, and attempts to improve the speed and functionality of software are the focus of the enhancement effort. The assessment effort is focused on validating the amount of time saved and the degree of acceptance among professors who had previously been unwillingly to exploit the WWW. Based on experiences with the tool, it is believed that HCC will have a significant impact on both.

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